PATENT ABSTRACTS OF JAPAN

(11)Publication number : 11-229159
(43)Date of publication of application : 24.08.1999

(51)Int.Cl. C23C 26/00

(21)Application number : 10-033182
(22)Date of filing : 16.02.1998

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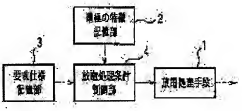
(54) ELECTRIC DISCHARGE SURFACE TREATMENT DEVICE, AND ELECTRIC DISCHARGE SURFACE TREATMENT METHOD

(57)Abstract:

PROBLEM TO BE SOLVED: To form a surface treated layer to satisfy the specification requested to a work to be treated by providing an electric discharge treatment condition control part to control the discharge treatment condition of an electric discharge treating means by the output result from an electrode characteristic storage part and the requested specification of a requested specification storage part.



SOLUTION: The requested specifications such as the hardness, the wear resistance, the film thickness and the surface roughness of a surface treated layer to be formed on a work are stored in a requested specification storage part 3, and the characteristics on the discharge of a dust electrode, for example, the composition of the electrode material, the electrode length and the electrode area are stored in an electrode characteristic storage part 2. The discharge treatment condition such as the polarity of the discharge pulse, the peak current, the open voltage, the pulse-ON time, the pulse-OFF time or the servo voltage suitable for the discharge treatment are set by a discharge treatment condition control part 4 by the storage parts 2, 3. The discharge treatment is achieved by a discharge treating means 1 based thereon, and the discharge treatment is completed when

the surface treated layer meets the requested specifications.

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Japanese Patent Laid-open Publication No.: HEI 11-229159A
Publication date : August 24, 1999
Applicant : MITSUBISHI DENKI KABUSHIKI KAISHA
Title :DISCHARGE SURFACE PROCESSING APPARATUS AND DISCHARGE SURFACE PROCESSING METHOD USING THE APPARATUS

(57)[Abstract]
[Problem to be solved] To obtain a discharge surface processing apparatus capable of forming a surface process layer that satisfies required specifications on a material to be processed.
[Solution] A discharge surface processing apparatus includes a discharge processing unit, a required specification storage unit, a feature storage unit of an electrode, and a discharge processing condition control unit. The discharge processing condition control unit controls a processing condition of the discharge processing unit from an output result from the feature storage unit of the electrode and from the required specifications of the required specification storage unit.

[0020] Third Embodiment. A case that a surface process layer (required specifications of a surface process layer) having excellent surface properties is formed on a material to be processed using the discharge surface processing

apparatus shown in the first embodiment will be explained. Figs. 5(a) and 5(b) are explanatory views used for explaining the operation of the discharge processing condition control unit in the discharge surface processing apparatus of the first embodiment. Figs. 5(a) and 5(b) depict characteristics (Fig. 5(a)) indicating a relation of surface properties by discharge processing energy (discharge processing condition) when a green compact electrode comprising different particle diameters (feature of the electrode) is used, and also depict characteristics (Fig. 5(b)) indicating a relation between the discharge processing energy and a film thickness of a surface process layer. In Figs. 5(a) and 5(b), the discharge processing energy is a product of peak current and pulse ON time. When the particle diameter is 5μm (o in Figs. 5(a) and 5(b)), discharge processing energy is selected from E1 to E2 in terms of surface properties as shown in Fig. 5(a), and optimal discharge processing energy may be determined in terms of film thickness as shown in Fig. 5(b). When the particle diameter is 1μm (Δ in the Figs. 5(a) and 5(b)), the film thickness is increased with the discharge processing energy used when the particle diameter is 5μm, but the surface properties are deteriorated. Therefore, if

the discharge processing energy is selected from E0 to E1, a film having high quality can be formed.

[Fig. 5] Figs. 5(a) and 5(b) are explanatory views for explaining the operation of a discharge processing condition control unit in a discharge surface processing apparatus of the present invention.

(a) Inferior Surface properties Superior
Particle diameter Discharge processing energy

(b) Thicker Film thickness Thinner
Particle diameter Discharge processing energy

(19)日本国特許庁（ＪＰ）　(12)公開特許公報（A）　(11)特許出願公開番号
特開平11－229159
(43)公開日　平成11年(1999)８月24日

(51)Int.Cl.[6]	識別記号	ＦＩ	
Ｃ２３Ｃ　26/00		Ｃ２３Ｃ　26/00	Ｄ

審査請求　未請求　請求項の数９　ＯＬ　（全　６　頁）

(21)出願番号　特願平10－33182

(22)出願日　平成10年(1998)２月16日

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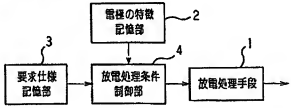
(54)【発明の名称】　放電表面処理装置およびこれを用いた放電表面処理方法

(57)【要約】
【課題】　被処理材に要求仕様を満たす表面処理層を形成することができる放電表面処理装置を得る。
【解決手段】　放電表面処理装置は放電処理手段、要求仕様記憶部、電極の特徴記憶部および放電処理条件制御部を備えたものである。電極の特徴記憶部からの出力結果と要求仕様記憶部の要求仕様とから放電処理手段の処理条件を放電処理条件制御部により制御する。



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【特許請求の範囲】

【請求項１】　表面処理材料または表面処理材料の元となる材料からなる圧粉体電極と被処理材との間に電圧を印加して放電を発生させることにより上記被処理材の表面に表面処理層を形成する放電処理手段、上記表面処理層の要求仕様を記憶する要求仕様記憶部、上記圧粉体電極の放電処理に関連する特性を記憶する電極の特徴記憶部、並びにこの電極の特徴記憶部からの出力結果と上記要求仕様記憶部の要求仕様とから上記放電処理手段の放電処理条件を制御する放電処理条件制御部を備えた放電表面処理装置。

【請求項２】　放電処理条件が放電パルスの極性、ピーク電流、オープン電圧、パルスオン時間、パルスオフ時間またはサーボ電圧であることを特徴とする請求項１に記載の放電表面処理装置。

【請求項３】　放電処理に関連する電極の特性が、電極材料成分もしくは粒径、電極長さ、電極面積、電極成型圧または傾斜的上記特性であることを特徴とする請求項１に記載の放電表面処理装置。

【請求項４】　傾斜的特性が電極材料成分または粒径であることを特徴とする請求項３に記載の放電表面処理装置。

【請求項５】　表面処理材料または表面処理材料の元となる材料からなる圧粉体電極と被処理材との間に電圧を印加して放電処理することにより上記被処理材の表面に表面処理層を形成する放電表面処理方法において、上記表面処理層の要求仕様と、上記圧粉体電極の放電処理に関連する特性とにより上記放電処理条件を制御する放電表面処理方法。

【請求項６】　放電処理条件の制御を放電処理状態または表面処理層の性状によりおこなうことを特徴とする請求項５に記載の放電表面処理方法。

【請求項７】　放電処理条件が放電パルスの極性、ピーク電流、オープン電圧、パルスオン時間、パルスオフ時間またはサーボ電圧であることを特徴とする請求項５または請求項６に記載の放電表面処理方法。

【請求項８】　放電処理に関連する電極の特性が、電極材料成分もしくは粒径、電極長さ、電極面積、電極成型圧または傾斜的上記特性であることを特徴とする請求項５または請求項６に記載の放電表面処理方法。

【請求項９】　傾斜的特性が電極材料成分または粒径であることを特徴とする請求項８に記載の放電表面処理方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、例えば金属またはセラミック等に一放電表面処理により表面処理層を形成する放電表面処理装置およびこれを用いた放電表面処理方法に関するものである。

【０００２】

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【従来の技術】図８は例えば特開平７－７０７６１号公報に記載されている液中放電による表面処理装置を説明するための説明図で、液中放電によって例えばアルミニウムまたはアルミニウム合金等の金属材料の被処理材表面をコーティングして、耐食性や耐摩耗性を与えるものである。図８において６は被処理材、８は加工液で例えばケロシン等の油を用い、１４は圧粉体電極、１５は被処理材６に形成された表面処理層である。例えば、被処理材６の表面にＴｉ系の被膜を形成する場合、まず、ＴｉＨ₂（水素化チタン）系の圧粉体電極１４により、ケロシン等放電により炭素を発生する加工液中８において放電を発生させる。この放電により電極１４が消耗し、その成分であるＴｉが極間に放出される。このＴｉが放電により熱分解された加工液の成分である炭素と反応してＴｉＣとなり、被処理材６の表面に表面処理層１５が形成できる。

【０００３】

【発明が解決しようとする課題】しかしながら、例えば、上記のようにして、ＴｉＨ₂（水素化チタン）の圧粉体電極によりアルミ合金への表面処理を行った場合には、アルミ合金とＴｉＣ被膜の硬度差が大きすぎるために、すぐに被膜が剥離してしまうという課題があった。また、圧粉体電極の材料成分もしくは粒径、電極長さ、電極面積または電極製作時の成形圧などが異なる場合や、電極が傾斜的特性を有する場合には、圧粉体電極の部分により電気伝導度や熱伝導度が異なるため、表面処理中の放電エネルギーが一定の場合、電極消耗状況が異なるので、面性状が悪化し、密着性や耐摩耗性に劣る表面処理層が形成されるという課題があった。即ち、従来の放電表面処理装置を用いた表面処理方法では、被処理材に要求仕様を満たす表面処理層を形成することができなかった。

【０００４】本発明は、かかる課題を解決するためになされたもので、被処理材に要求仕様を満たす表面処理層を形成することができる放電表面処理装置およびこれを用いた放電表面処理方法を得ることを目的とする。

【０００５】

【課題を解決するための手段】本発明に係る第１の放電表面処理装置は、表面処理材料または表面処理材料の元となる材料からなる圧粉体電極と被処理材との間に電圧を印加して放電を発生させることにより上記被処理材の表面に表面処理層を形成する放電処理手段、上記表面処理層の要求仕様を記憶する要求仕様記憶部、上記圧粉体電極の放電処理に関連する特性を記憶する電極の特徴記憶部、並びにこの電極の特徴記憶部からの出力結果と上記要求仕様記憶部の要求仕様とから上記放電処理手段の放電処理条件を制御する放電処理条件制御部を備えたものである。

【０００６】本発明に係る第２の放電表面処理装置は、上記第１の放電表面処理装置において、放電処理条件が

放電パルスの極性、ピーク電流、オープン電圧、パルスオン時間、パルスオフ時間またはサーボ電圧のものである。

【０００７】本発明に係る第３の放電表面処理装置は、上記第１の放電表面処理装置において、放電処理に関連する電極の特性が、電極材料成分もしくは粒径、電極長さ、電極面積、電極成型圧または傾斜的上記特性のものである。

【０００８】本発明に係る第４の放電表面処理装置は、上記第３の放電表面処理装置において、傾斜的特性が電極材料成分または粒径のものである。

【０００９】本発明に係る第１の放電表面処理方法は、表面処理材料または表面処理材料の元となる材料からなる圧粉体電極と被処理材との間に電圧を印加して放電処理することにより上記被処理材の表面に表面処理層を形成する放電表面処理方法において、上記表面処理層の要求仕様と、上記圧粉体電極の放電処理に関連する特性とにより上記放電処理条件を制御する方法である。

【００１０】本発明に係る第２の放電表面処理方法は、上記第１の放電表面処理方法において、放電処理条件の制御を放電処理状態または表面処理層の性状によりおこなう方法である。

【００１１】本発明に係る第３の放電表面処理方法は、上記第１または第２の放電表面処理方法において、放電処理条件が放電パルスの極性、ピーク電流、オープン電圧、パルスオン時間、パルスオフ時間またはサーボ電圧の方法である。

【００１２】本発明に係る第４の放電表面処理方法は、上記第１または第２の放電表面処理方法において、放電処理に関連する電極の特性が、電極材料成分もしくは粒径、電極長さ、電極面積、電極成型圧または傾斜的上記特性の方法である。

【００１３】本発明に係る第５の放電表面処理方法は、上記第４の放電表面処理方法において、傾斜的特性が電極材料成分または粒径の方法である。

【００１４】

【発明の実施の形態】実施の形態１．図１は本発明の第１の実施の形態の放電表面処理装置の構成を示す説明図であり、図２はこの放電表面処理装置を用いた放電表面処理の処理過程を示すフローチャートである。図において、１は表面処理材料または表面処理材料の元となる材料からなる圧粉体電極と被処理材との間に電圧を印加して放電を発生させることにより上記被処理材の表面に表面処理層を形成する放電処理手段、２は圧粉体電極の放電に関連する電極の特性を記憶する電極の特徴記憶部、３は被処理材に形成される表面処理材の要求仕様を記憶する要求仕様記憶部、４は電極の特徴記憶部２からの出力結果と上記要求仕様記憶部の要求仕様とから上記放電処理手段１の放電処理条件を制御する放電処理条件制御部である。

【００１５】まず、ステップ１で被処理材に形成する表面処理層の硬度、耐摩耗性、密着性、膜厚または面あらさなどの要求仕様を要求仕様記憶部３に記憶し、ステップ２で圧粉体電極の放電に関連した特性、例えば電極材料成分もしくは粒径、電極長さ、電極面積、電極製作時の成形圧または電極の傾斜的上記特性等を記憶する。次に、ステップ３で電極の特徴記憶部２と要求仕様記憶部３とから、放電処理に適した放電パルスの極性、ピーク電流、オープン電圧、パルスオン時間、パルスオフ時間またはサーボ電圧等の放電処理条件を放電処理条件制御部４により設定し、それに基づきステップ４で放電処理手段１により放電処理をおこない、ステップ５で表面処理層が要求仕様に達した時点で放電処理を終了する。なお、ステップ１とステップ２は前後してもよい。

【００１６】実施の形態２．実施の形態１に示した放電表面処理装置を用いて、被処理材に硬度変化がなめらかである表面処理層（表面処理層の要求仕様）を形成する場合について説明する。図３は上記実施の形態１における放電表面処理装置による被処理材の放電処理を説明する説明図である。図において、６は被処理材、８は加工液でケロシン等の油、５は圧粉体電極、７は表面処理層である。また、圧粉体電極５としては、ＴｉＨ２の粉体量とＮｉの粉体量を徐々に変化させ組成に傾斜性をもたせたもの（電極の特徴）を用いた。即ち、被処理材６側は比較的柔らかい金属であるＮｉ粉体の量を、比較的硬い金属であるＴｉを含むＴｉＨ２粉体の量より多くなるように徐々に変化させている。次に、上記電極を用いて上記表面処理層を被処理材に形成するための放電処理条件として、電極と被処理材間に一定の放電エネルギーで放電を発生させると設定し、ケロシン等放電により炭素を発生する加工液中８において放電処理し、図に示すように成分に傾斜性を有する表面処理層７を得ることができた。即ち、被処理材６と表面処理層７との接触部分にはＮｉ量が多く、表面処理層７の上面部に向かってＮｉ量が減少し、それにつれて従来と同様にして得られたＴｉＣの量が増加するので、ＴｉＣ単独で形成されているより硬度変化がなめらかとなり、高硬度な表面処理層被膜の形成と同時にその剥離を抑制することができた。

【００１７】なお、本実施の形態で用いた圧粉体電極５は、粒径１０μｍ程度の粉体を用い、Ｎｉ粉体量：ＴｉＨ２粉体量＝７：３～０：１０（体積％）で連続的に変化させたものを用い傾斜性をもたせた。なお、上記電極は例えば混合比率の異なる粉体を電極型内に積層させた後、加圧成形することにより製作した。

【００１８】また、図４のように、圧粉体電極５のワーク６側を比較的柔らかい金属であるＮｉの粉体で形成し、他を比較的硬い金属であるＴｉを含むＴｉＨ２の粉体で形成することにより上記と同様の効果を得ることができる。図４は本発明の第２の実施の形態で用いることができる圧粉体電極の説明図で、図において、９は圧粉

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体電極、10はNiの粉体で形成された部分、11はTiHzの粉体で形成された部分である。

【0019】また、本圧粉体電極の傾斜性を電極材料成分にもたせたが、圧粉体電極の傾斜性を粒径（例えば2～20μm）または電極材料と粒径の両方にもたせることでもよい。また、Ti以外にもV（バナジウム）、Nb（ニオブ）、Ta（タンタル）、Cr（クロム）、Mo（モリブデン）またはW（タングステン）等を使用しても、さらにこれらに他の金属やセラミックス等を混合したものを使用しても同様の効果を得ることができる。

【0020】実施の形態3．実施の形態1に示した放電表面処理装置を用いて、被処理材に面性状に優れた表面処理層（表面処理層の要求仕様）を形成する場合について説明する。図5は本発明の実施の形態1の放電表面処理装置における放電処理条件制御部の動作を説明するための説明図で、異なる粒径からなる圧粉体電極（電極の特徴）を用いた場合の放電処理エネルギー（放電処理条件）による面性状の関係を示す特性図［図5（a）］と、放電処理エネルギーと表面処理層の膜厚との関係を示す特性図［図5（b）］を示す。図において放電処理エネルギーとはピーク電流とパルスオン時間の積である。粒径が5μmの場合（図中○）には、図5（a）に示すように面性状の点から放電処理エネルギーはE1～E2から選らばれ、図5（b）に示すように膜厚の点から最適な放電処理エネルギーを決定すればよい。一方、粒径が1μmの場合（図中△）には、粒径が5μmの場合に使用した放電処理エネルギーでは、膜厚が厚くなるものの面性状が悪化するため、放電処理エネルギーはE0～E1から選ぶことにより良質な被膜を形成することができる。

【0021】実施の形態4．図6は本発明の第4の実施の形態の放電表面処理装置の構成を示す説明図であり、図7はこの放電表面処理装置を用いた放電表面処理の処理過程を示すフローチャートである。図において、1～4は図1と同様であり、12は放電処理手段1で放電が正常に行われているか（例えば短絡が生じているか）否かを検出する放電処理状態検出部、13は表面処理層の性状が正常であるか否かを検出する表面処理層の性状検出部である。つまり、最初に設定する放電処理条件は外乱の影響がないものと想定しているが、実際は処理くずの排出状態等により上記条件では対応できない状態が発生する。これを例えば短絡状態で、連続して放電が発生しているか否かを検出する。また、例えば最初に設定した放電処理条件が不適切であるか、または放電の進行に伴い放電処理条件が不適切になると、面粗さが悪くなり、被膜の厚さが不均一になり表面処理層の性状が悪くなることから、表面層の性状から放電処理状態を検出することができる。

【0022】まず、図7において、ステップ4までは図2と同様にして放電処理手段1により放電処理をおこなう。処理時間が長くなると放電処理中に圧粉体電極の特徴が変化するが、その変化に対応することにより、より要求仕様に沿った表面処理層を得ることができる。即ち、図7において、ステップ6、7で放電処理中、放電処理状態が正常であるか否かを判断し、異常であれば放電処理条件制御部4で放電処理条件を修正し正常ならステップ8、9で、被処理材に形成された表面処理層の性状が正常であるか否かを判断し、異常であれば放電処理条件制御部4で放電処理条件を修正し正常ならステップ5で表面処理層が要求仕様に達した時点で放電処理を終了する。なお、ステップ1とステップ2およびステップ6、7とステップ8、9は前後してもよく、ステップ6、7とステップ8、9は実行回数を最初から決めていても良い。

【0023】実施の形態1に示す放電表面処理装置を用いた放電表面処理方法のように、放電処理条件制御部による放電処理条件の決定は、表面処理前に一度だけ実行しても良いが、処理中に圧粉体電極等の特徴が変化する場合または形成する表面処理層が厚膜（20μm程度）である場合、良質な表面処理層を得るためには実施の形態4に示す放電表面処理装置を用いた放電表面処理方法のように、放電処理条件制御部による放電条件の決定を複数回実行して修正することが望ましい。

【0024】

【発明の効果】本発明の第1の放電表面処理装置によれば、表面処理材料または表面処理材料の元となる材料からなる圧粉体電極と被処理材との間に電圧を印加して放電を発生させることにより上記被処理材の表面に表面処理層を形成する放電処理手段、上記表面処理層の要求仕様を記憶する要求仕様記憶部、上記圧粉体電極の放電処理に関連する特性を記憶する電極の特徴記憶部、並びにこの電極の特徴記憶部からの出力結果と上記要求仕様記憶部の要求仕様とから上記放電処理手段の放電処理条件を制御する放電処理条件制御部を備えたものであり、被処理材に要求仕様を満たす表面処理層を形成することができるという効果がある。

【0025】本発明の第2の放電表面処理装置によれば、上記第1の放電表面処理装置において、放電処理条件が放電パルスの極性、ピーク電流、オープン電圧、パルスオン時間、パルスオフ時間またはサーボ電圧のものであり、被処理材に要求仕様を満たす表面処理層を形成することができるという効果がある。

【0026】本発明の第3の放電表面処理装置によれば、上記第1の放電表面処理装置において、放電処理に関連する電極の特性が、電極材料成分もしくは粒径、電極長さ、電極面積、電極成型圧または傾斜的上記特性のものであり、被処理材に要求仕様を満たす表面処理層を形成することができるという効果がある。

【0027】本発明の第4の放電表面処理装置によれば、上記第3の放電表面処理装置において、傾斜的特性

が電極材料成分または粒径のものであり、被処理材に要求仕様を満たす表面処理層を形成することができるという効果がある。

【００２８】本発明の第１の放電表面処理方法は、表面処理材料または表面処理材料の元となる材料からなる圧粉体電極と被処理材との間に電圧を印加して放電処理することにより上記被処理材の表面に表面処理層を形成する放電表面処理方法において、上記表面処理層の要求仕様と、上記圧粉体電極の放電処理に関連する特性とにより上記放電処理の放電処理条件を制御する方法であり、被処理材に要求仕様を満たす表面処理層を形成することができるという効果がある。

【００２９】本発明の第２の放電表面処理方法は、上記第１の放電表面処理装置において、放電処理条件の制御を放電処理状態または表面処理層の性状によりおこなう方法であり、被処理材に要求仕様をさらに満たす表面処理層を形成することができるという効果がある。

【００３０】本発明の第３の放電表面処理方法は、上記第１または第２の放電表面処理方法において、放電処理条件が放電パルスの極性、ピーク電流、オープン電圧、パルスオン時間、パルスオフ時間またはサーボ電圧であり、被処理材により十分に要求仕様を満たす表面処理層を形成することができるという効果がある。

【００３１】本発明の第４の放電表面処理方法は、上記第１または第２の放電表面処理方法において、放電処理に関連する電極の特性が、電極材料成分もしくは粒径、

電極長さ、電極面積、電極成型圧または傾斜的上記特性であり、被処理材に要求仕様を満たす表面処理層を形成することができるという効果がある。

【００３２】本発明の第５の放電表面処理方法は、上記第４の放電表面処理方法において、傾斜的特性が電極材料成分または粒径であり、被処理材に要求仕様を満たす表面処理層を形成することができるという効果がある。

【図面の簡単な説明】

【図１】　本発明に係わる放電表面処理装置の構成を示す説明図である。

【図２】　本発明に係わる放電表面処理装置を用いた放電表面処理の処理過程を示すフローチャートである。

【図３】　本発明に係わる放電表面処理装置による被処理材の放電処理を説明する説明図である。

【図４】　本発明に係わる圧粉体電極の説明図である。

【図５】　本発明に係わる放電表面処理装置における放電処理条件制御部の動作を説明するための説明図である。

【図６】　本発明に係わる放電表面処理装置の構成を示す説明図である。

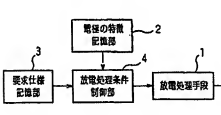
【図７】　本発明に係わる放電表面処理装置を用いた放電表面処理の処理過程を示すフローチャートである。

【図８】　従来の放電表面処理装置による被処理材の放電処理を説明する説明図である。

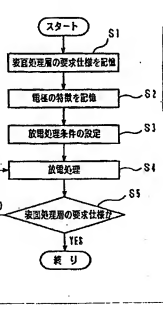
【符号の説明】

５　圧粉体電極、７　表面処理層。

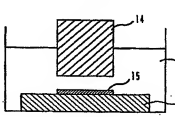
【図１】



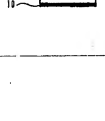
【図２】



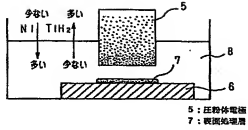
【図８】



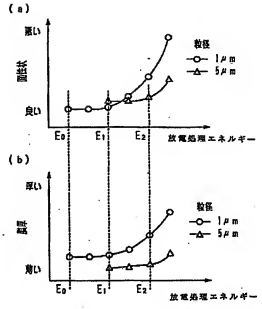
【図４】



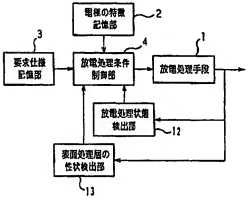
【図３】


少ない
多い
Ni
TiH2
多い
少ない
5
8
7
6
5：圧粉体電極
7：表面処理層

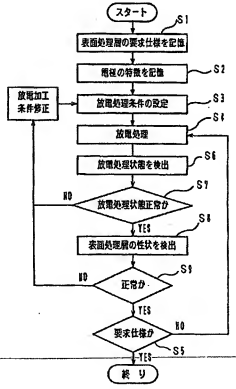
【図５】


(a)
悪い
表面
良い
粒径
1μm
5μm
E0
E1
E2
放電処理エネルギー
(b)
厚い
膜厚
薄い
粒径
1μm
5μm
E0
E1
E2
放電処理エネルギー

【図６】


電極の特徴記憶部
2
3
要求仕様記憶部
4
放電処理条件制御部
放電処理手段
1
放電処理状態検出部
12
表面処理層の性状検出部
13

【図７】


スタート
S1
表面処理層の要求仕様を記憶
電極の特徴を記憶
S2
放電加工条件修正
放電処理条件の設定
S3
S4
放電処理
S6
放電処理状態を検出
S7
NO
放電処理状態正常か
YES
S8
表面処理層の性状を検出
S9
NO
正常か
YES
要求仕様か
NO
YES
S5
終り

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention]This invention relates, for example to the electric discharge surface treatment method using the discharge surface treatment equipment and this which form a surface treatment layer in metal, ceramics, etc. by discharge surface treatment.

[0002]

[Description of the Prior Art]Drawing 8 is an explanatory view for explaining the surface treatment device by the discharge among liquid indicated to JP,7-70761,A, by discharge among liquid, coats the processed material surface of metallic materials, such as aluminum or an aluminum alloy, and gives corrosion resistance and abrasion resistance. He is the surface treatment layer by whom 6 used processed material, 8 used oils, such as kerosene, with working liquid in drawing 8, 14 was formed in the green compact electrode and 15 was formed in the processed material 6. For example, when forming the tunic of a Ti system in the surface of the processed material 6, in eight in working liquid which generates carbon by discharge, such as kerosene, discharge is first generated by the green compact electrode 14 of a TiH_2 (titanium hydride) system. The electrode 14 is exhausted by this discharge and Ti which is that ingredient is emitted very much in between. This Ti reacts to carbon which is an ingredient of the working liquid the pyrolysis was carried out by discharge of, it is set to TiC, and the surface treatment layer 15 can be formed in the surface of the processed material 6.

[0003]

[Problem(s) to be Solved by the Invention]However, since the hardness difference of an aluminum containing alloy and a TiC tunic was too large when the green compact electrode of TiH_2 (titanium hydride), for example, performs the surface treatment to an aluminum containing alloy as mentioned above, the technical problem that a tunic will exfoliate immediately occurred. When the material component of a green compact electrode or particle diameter,

electrode length, and an electrode area differ from the moulding pressure at the time of electrode manufacture, etc., or when an electrode has the inclination characteristic, Since electrical conductivity and thermal conductivity changed with portions of a green compact electrode and electrode wear situations differed when the spark discharge energy under surface treatment was constant, the shape of planarity got worse and the technical problem that the surface treatment layer inferior to adhesion or abrasion resistance was formed occurred. That is, in the surface treatment method using conventional discharge surface treatment equipment, the surface treatment layer who fulfills requirement specification was not able to be formed in processed material.

[0004]This invention was made in order to solve this technical problem, and an object of this invention is to acquire the electric discharge surface treatment method using the discharge surface treatment equipment and this which can form the surface treatment layer who fulfills requirement specification to processed material.

[0005]

[Means for Solving the Problem]An electrodischarge treatment means to form a surface treatment layer in the surface of the above-mentioned processed material by the 1st discharge surface treatment equipment concerning this invention impressing voltage between a green compact electrode and processed material which consist of material which becomes origin of surface treatment materials or surface treatment materials, and generating discharge, A requirement specification storage parts store which memorizes the above-mentioned surface treatment layer's requirement specification, a characteristic storage section of an electrode which memorizes the characteristic relevant to electrodischarge treatment of the above-mentioned green compact electrode, And it has an electrodischarge treatment conditional-control part which controls electrodischarge treatment conditions of the above-mentioned electrodischarge treatment means from an output from a characteristic storage section of this electrode, and requirement specification of the above-mentioned requirement specification storage parts store.

[0006]In the 1st discharge surface treatment equipment of the above, electrodischarge treatment conditions of the 2nd discharge surface treatment equipment concerning this invention are the things of polarity [of a discharge pulse], peak current, open voltage, and pulse ON time, pulse OFF time, or servo voltage.

[0007]The characteristic of an electrode on the 1st discharge surface treatment equipment of the above and relevant to electrodischarge treatment in the 3rd discharge surface treatment equipment concerning this invention is a thing of an electrode material ingredient or particle diameter, electrode length, an electrode area, electrode molding pressure, or the inclination above-mentioned characteristic.

[0008]In the 3rd discharge surface treatment equipment of the above, the inclination

characteristic of the 4th discharge surface treatment equipment concerning this invention is a thing of an electrode material ingredient or particle diameter.

[0009]In an electric discharge surface treatment method which forms a surface treatment layer in the surface of the above-mentioned processed material when the 1st electric discharge surface treatment method concerning this invention impresses and carries out electrodischarge treatment of the voltage between a green compact electrode and processed material which consist of material which becomes origin of surface treatment materials or surface treatment materials, It is the method of controlling the above-mentioned electrodischarge treatment conditions by the above-mentioned surface treatment layer's requirement specification, and the characteristic relevant to electrodischarge treatment of the above-mentioned green compact electrode.

[0010]The 2nd electric discharge surface treatment method concerning this invention is the method of controlling electrodischarge treatment conditions by an electrodischarge treatment state or a surface treatment layer's description in the 1st electric discharge surface treatment method of the above.

[0011]In the 1st or 2nd electric discharge surface treatment method of the above, electrodischarge treatment conditions of the 3rd electric discharge surface treatment method concerning this invention are the methods of polarity [of a discharge pulse], peak current, open voltage, and pulse ON time, pulse OFF time, or servo voltage.

[0012]The characteristic of an electrode on the 1st or 2nd electric discharge surface treatment method of the above and relevant to electrodischarge treatment in the 4th electric discharge surface treatment method concerning this invention is the method of an electrode material ingredient or particle diameter, electrode length, an electrode area, electrode molding pressure, or the inclination above-mentioned characteristic.

[0013]In the 4th electric discharge surface treatment method of the above, the inclination characteristic of the 5th electric discharge surface treatment method concerning this invention is the method of an electrode material ingredient or particle diameter.

[0014]

[Embodiment of the Invention]Embodiment 1. drawing 1 is an explanatory view showing the composition of the discharge surface treatment equipment of a 1st embodiment of this invention, and drawing 2 is a flow chart which shows the processing process of the discharge surface treatment which used this discharge surface treatment equipment. An electrodischarge treatment means to form a surface treatment layer in the surface of the above-mentioned processed material by 1 impressing voltage in a figure between the green compact electrode and processed material which consist of material which becomes the origin of surface treatment materials or surface treatment materials, and generating discharge, The characteristic storage section of an electrode which memorizes the characteristic of the

electrode relevant to discharge of a green compact electrode in 2, The requirement specification storage parts store which memorizes the requirement specification of the surface treating material by which 3 is formed in processed material, and 4 are electrodischarge treatment conditional-control parts which control the electrodischarge treatment conditions of the above-mentioned electrodischarge treatment means 1 from the output from the characteristic storage section 2 of an electrode, and the requirement specification of the above-mentioned requirement specification storage parts store.

[0015]First, hardness of the surface treatment layer who forms in processed material at Step 1, abrasion resistance, Requirement specification, such as adhesion, thickness, or field surface roughness, is memorized to the requirement specification storage parts store 3, and the characteristic relevant to discharge of the green compact electrode, for example, an electrode material ingredient, particle diameter, electrode length, an electrode area, the moulding pressure at the time of electrode manufacture, or the inclination above-mentioned characteristic of an electrode is memorized at Step 2. Next, at Step 3 from the characteristic storage section 2 and the requirement specification storage parts store 3 of an electrode. Polarity [of a discharge pulse suitable for electrodischarge treatment], peak current, open voltage, and pulse ON time, Electrodischarge treatment conditions, such as pulse OFF time or servo voltage, are set up by the electrodischarge treatment conditional-control part 4, the electrodischarge treatment means 1 performs electrodischarge treatment at Step 4 based on it, and electrodischarge treatment is ended when a surface treatment layer reaches requirement specification at Step 5. Step 1 and Step 2 may get mixed up.

[0016]The case where a hardness change forms a smooth surface treatment layer (a surface treatment layer's requirement specification) in processed material is explained using the discharge surface treatment equipment shown in the embodiment 2. embodiment 1. Drawing 3 is an explanatory view explaining the electrodischarge treatment of the processed material by the discharge surface treatment equipment in the above-mentioned Embodiment 1. As for processed material and 8, in a figure, a green compact electrode and 7 are surface treatment layers oils, such as kerosene, and 5 in working liquid 6. As the green compact electrode 5, what changed the powder quantity of TiH_2 and the powder quantity of nickel gradually, and gave lopsidedness to the presentation (the feature of an electrode) was used. That is, the processed material 6 side is gradually changed so that it may increase more than the quantity of the TiH_2 granular material containing Ti which is comparatively hard metal about the quantity of the Ni-powder object which is comparatively soft metal. Next, as electrodischarge treatment conditions for forming the above-mentioned surface treatment layer in processed material using the above-mentioned electrode, It was able to set up, when discharge was generated with fixed spark discharge energy between an electrode and processed material, and electrodischarge treatment was able to be carried out in eight in working liquid which

generates carbon by discharge, such as kerosene, and the surface treatment layer 7 who has lopsidedness for an ingredient as shown in a figure was able to be obtained. Namely, since the quantity of TiC produced by the contacting parts of the processed material 6 and the surface treatment layer 7 having many amounts of nickel, and the amount of nickel decreasing toward the surface treatment layer's 7 upper face part, and making it be the same as usual along with it increases, The hardness change became smooth and the exfoliation was able to be controlled simultaneously with formation of a high hardness surface treatment layer tunic rather than formed by a TiC independent.

[0017]The green compact electrode 5 used by this embodiment gave lopsidedness using what was continuously changed using the granular material with a particle diameter of about 10 micrometers by Ni-powder body weight:TiH_2 powder quantity =7:3 - 0:10 (volume %). The above-mentioned electrode was manufactured by carrying out pressing, after making the granular material in which the mixing ratio differs laminate in an electrode type.

[0018]The same effect as the above can be acquired by forming the work 6 side of the green compact electrode 5 like drawing 4 with the granular material of nickel which is comparatively soft metal, and forming with the granular material of TiH_2 containing Ti which is comparatively hard metal about others. Drawing 4 is an explanatory view of a green compact electrode which can be used by a 2nd embodiment of this invention, and the portion in which 9 was formed in by the green compact electrode, and 10 was formed with the granular material of nickel, and 11 are the portions formed with the granular material of TiH_2 in a figure.

[0019]Although the lopsidedness of this green compact electrode was given to the electrode material ingredient, it is possible to give the lopsidedness of a green compact electrode to both particle diameter (for example, 2-20 micrometers), or an electrode material and particle diameter. The same effect can be acquired even if it uses what mixed metal, ceramics, etc. of others [these] further even if it used V (vanadium), Nb (niobium), Ta (tantalum), Cr (chromium), Mo (molybdenum), or W (tungsten) besides Ti.

[0020]The case where the surface treatment layer (a surface treatment layer's requirement specification) who was excellent in processed material in the shape of planarity is formed using the discharge surface treatment equipment shown in the embodiment 3. embodiment 1 is explained. Drawing 5 is an explanatory view for explaining operation of the electrodischarge treatment conditional-control part in the discharge surface treatment equipment of the embodiment of the invention 1, The characteristic figure {drawing 5 (a)} showing the planar relation by the electrodischarge treatment energy (electrodischarge treatment conditions) at the time of using the green compact electrode (the feature of an electrode) which consists of different particle diameter, and the characteristic figure {drawing 5 (b)} showing the relation between electrodischarge treatment energy and a surface treatment layer's thickness are

shown. In a figure, electrodischarge treatment energy is a product of peak current and pulse ON time. What is necessary is just to determine the optimal electrodischarge treatment energy from a point of thickness, as shown in ** and drawing 5 (b) if electrodischarge treatment energy is chosen from a planar point from E1-E2 as shown in drawing 5 (a) when particle diameter is 5 micrometers (O in a figure). On the other hand, with the electrodischarge treatment energy used when particle diameter was 5 micrometers, when particle diameter is 1 micrometer (** in a figure), since the shape of planarity of that to which thickness becomes thick gets worse, the electrodischarge treatment energy can form a good tunic by choosing out of E0-E1.

[0021]Embodiment 4. drawing 6 is an explanatory view showing the composition of the discharge surface treatment equipment of a 4th embodiment of this invention, and drawing 7 is a flow chart which shows the processing process of the discharge surface treatment which used this discharge surface treatment equipment. In a figure, 1-4 are the same as that of drawing 1, and they are an electrodischarge treatment state detection part from which discharge is normally performed by the electrodischarge treatment means 1, or (for example, has the short circuit arisen?) 12 detects whether it is no, and a description primary detecting element of the surface treatment layer who detects whether the description of 13 of a surface treatment layer is normal. That is, although it assumes that the electrodischarge treatment conditions set up first do not have influence of disturbance, the state where it cannot respond on the above-mentioned conditions according to the ejection state of processing waste, etc. in practice occurs. It is detected whether in the short condition, discharge has generated this continuously. If the electrodischarge treatment conditions set up first, for example are unsuitable or electrodischarge treatment conditions become unsuitable with advance of discharge, since surface roughness will worsen, the thickness of a tunic will become uneven and a surface treatment layer's description will worsen, an electrodischarge treatment state is detectable from the description of a surface layer.

[0022]First, in drawing 7, the electrodischarge treatment means 1 performs electrodischarge treatment like [Step 4] drawing 2. If processing time becomes long, the feature of a green compact electrode will change during electrodischarge treatment, but the surface treatment layer who met requirement specification more can be obtained by corresponding to the change. In drawing 7, judge whether an electrodischarge treatment state is normal during electrodischarge treatment at Steps 6 and 7, and if, and electrodischarge treatment conditions are amended and it is normal in the electrodischarge treatment conditional-control part 4, namely, at Steps 8 and 9. It judges whether a surface treatment layer's description formed in processed material is normal, and electrodischarge treatment is ended, when electrodischarge treatment conditions were amended in the electrodischarge treatment conditional-control part 4, and a surface treatment layer will reach requirement specification at Step 5 if normal if

unusual. Step 1, Step 2 and Steps 6 and 7, and Steps 8 and 9 could get mixed up, and Steps 6 and 7 and Steps 8 and 9 may determine execution frequency from the beginning.

[0023]The determination of the electrodischarge treatment conditions by an electrodischarge treatment conditional-control part like the electric discharge surface treatment method using the discharge surface treatment equipment shown in Embodiment 1, Although it may perform only once before a surface treatment, when the surface treatment layer from whom the features, such as a green compact electrode, change during processing and who case [a surface treatment layer] or forms is a thick film (about 20mmicro), In order to obtain a good surface treatment layer, it is desirable to carry out multiple-times execution and to correct the determination of the discharging condition by an electrodischarge treatment conditional-control part like the electric discharge surface treatment method using the discharge surface treatment equipment shown in Embodiment 4.

[0024]

[Effect of the Invention]An electrodischarge treatment means to form a surface treatment layer in the surface of the above-mentioned processed material by according to the 1st discharge surface treatment equipment of this invention impressing voltage between the green compact electrode and processed material which consist of material which becomes the origin of surface treatment materials or surface treatment materials, and generating discharge, The requirement specification storage parts store which memorizes the above-mentioned surface treatment layer's requirement specification, the characteristic storage section of an electrode which memorizes the characteristic relevant to the electrodischarge treatment of the above-mentioned green compact electrode, And it has an electrodischarge treatment conditional-control part which controls the electrodischarge treatment conditions of the above-mentioned electrodischarge treatment means from the output from the characteristic storage section of this electrode, and the requirement specification of the above-mentioned requirement specification storage parts store, and is effective in the ability to form the surface treatment layer who fulfills requirement specification to processed material.

[0025]In [according to the 2nd discharge surface treatment equipment of this invention] the 1st discharge surface treatment equipment of the above, Electrodischarge treatment conditions are the things of polarity [of a discharge pulse], peak current, open voltage, and pulse ON time, pulse OFF time, or servo voltage, and it is effective in the ability to form the surface treatment layer who fulfills requirement specification to processed material.

[0026]In [according to the 3rd discharge surface treatment equipment of this invention] the 1st discharge surface treatment equipment of the above, The characteristic of the electrode relevant to electrodischarge treatment is a thing of an electrode material ingredient or particle diameter, electrode length, an electrode area, electrode molding pressure, or the inclination above-mentioned characteristic, and it is effective in the ability to form the surface treatment

layer who fulfills requirement specification to processed material.
[0027]According to the 4th discharge surface treatment equipment of this invention, in the 3rd discharge surface treatment equipment of the above, the inclination characteristic is a thing of an electrode material ingredient or particle diameter, and it is effective in the ability to form the surface treatment layer who fulfills requirement specification to processed material.
[0028]In the electric discharge surface treatment method which forms a surface treatment layer in the surface of the above-mentioned processed material when the 1st electric discharge surface treatment method of this invention impresses and carries out electrodischarge treatment of the voltage between the green compact electrode and processed material which consist of material which becomes the origin of surface treatment materials or surface treatment materials, It is the method of controlling the electrodischarge treatment conditions of the above-mentioned electrodischarge treatment by the above-mentioned surface treatment layer's requirement specification, and the characteristic relevant to the electrodischarge treatment of the above-mentioned green compact electrode, and is effective in the ability to form the surface treatment layer who fulfills requirement specification to processed material.
[0029]The 2nd electric discharge surface treatment method of this invention is the method of controlling electrodischarge treatment conditions by an electrodischarge treatment state or a surface treatment layer's description in the 1st discharge surface treatment equipment of the above, and it is effective in the ability to form the surface treatment layer who fulfills requirement specification further to processed material.
[0030]In the 1st or 2nd electric discharge surface treatment method of the above the 3rd electric discharge surface treatment method of this invention, Electrodischarge treatment conditions are the polarity, peak current, open voltage, and pulse ON time, pulse OFF time, or servo voltage of a discharge pulse, and it is effective in the ability to form the surface treatment layer who fully fulfills requirement specification by processed material.
[0031]In the 1st or 2nd electric discharge surface treatment method of the above the 4th electric discharge surface treatment method of this invention, The characteristic of the electrode relevant to electrodischarge treatment is an electrode material ingredient or particle diameter, electrode length, an electrode area, electrode molding pressure, or the inclination above-mentioned characteristic, and it is effective in the ability to form the surface treatment layer who fulfills requirement specification to processed material.
[0032]In the 4th electric discharge surface treatment method of the above, the inclination characteristic is an electrode material ingredient or particle diameter, and the 5th electric discharge surface treatment method of this invention is effective in the ability to form the surface treatment layer who fulfills requirement specification to processed material.

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1]An electrodischarge treatment means to form a surface treatment layer in the surface of the above-mentioned processed material by impressing voltage between a green compact electrode and processed material which consist of material which becomes origin of surface treatment materials or surface treatment materials, and generating discharge, A requirement specification storage parts store which memorizes the above-mentioned surface treatment layer's requirement specification, a characteristic storage section of an electrode which memorizes the characteristic relevant to electrodischarge treatment of the above-mentioned green compact electrode, And discharge surface treatment equipment provided with an electrodischarge treatment conditional-control part which controls electrodischarge treatment conditions of the above-mentioned electrodischarge treatment means from an output from a characteristic storage section of this electrode, and requirement specification of the above-mentioned requirement specification storage parts store.
[Claim 2]The discharge surface treatment equipment according to claim 1, wherein electrodischarge treatment conditions are polarity, peak current, open voltage, and pulse ON time, pulse OFF time, or servo voltage of a discharge pulse.
[Claim 3]The discharge surface treatment equipment according to claim 1, wherein the characteristic of an electrode relevant to electrodischarge treatment is an electrode material ingredient or particle diameter, electrode length, an electrode area, electrode molding pressure, or the inclination above-mentioned characteristic.
[Claim 4]The discharge surface treatment equipment according to claim 3, wherein the inclination characteristic is an electrode material ingredient or particle diameter.
[Claim 5]In an electric discharge surface treatment method which forms a surface treatment layer in the surface of the above-mentioned processed material by impressing and carrying out electrodischarge treatment of the voltage between a green compact electrode and processed

material which consist of material which becomes origin of surface treatment materials or surface treatment materials, An electric discharge surface treatment method which controls the above-mentioned electrodischarge treatment conditions by the above-mentioned surface treatment layer's requirement specification, and the characteristic relevant to electrodischarge treatment of the above-mentioned green compact electrode.

[Claim 6]The electric discharge surface treatment method according to claim 5 controlling electrodischarge treatment conditions by an electrodischarge treatment state or a surface treatment layer's description.

[Claim 7]The electric discharge surface treatment method according to claim 5 or 6, wherein electrodischarge treatment conditions are polarity, peak current, open voltage, and pulse ON time, pulse OFF time, or servo voltage of a discharge pulse.

[Claim 8]The electric discharge surface treatment method according to claim 5 or 6, wherein the characteristic of an electrode relevant to electrodischarge treatment is an electrode material ingredient or particle diameter, electrode length, an electrode area, electrode molding pressure, or the inclination above-mentioned characteristic.

[Claim 9]The electric discharge surface treatment method according to claim 8, wherein the inclination characteristic is an electrode material ingredient or particle diameter.

[Translation done.]